APPENDIX A

CONCEPTUAL MODEL AND EPISODE SELECTION FOR THE SAN ANTONIO EAC REGION

Conceptual Model and Episode Selection for the San Antonio EAC Region

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INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is charged with the maintenance of regional air quality across the United States through a series of standards, the National Ambient Air Quality Standards (NAAQS). When regions fail to comply with these standards, the region joins together with the state and several federal entities to create and agree upon a State Implementation Plan (SIP). The SIP is a blueprint for the methodology that the region and state will follow to allow the region to regain the federal air quality standards.

Air quality analysis and the modeling of control strategies are elements of a SIP. Since control strategy modeling requires extensive technical analyses of control strategy impacts under all meteorological conditions that give rise to high levels of ozone formation, it is important that each photochemical modeling episode be built upon a time period characterized by such meteorological conditions. Hence, careful selection of the proper episode is important for use in photochemical modeling.

The EPA suggests that a conceptual description[1], or model, be developed to aid in the selection of modeling episodes. The following paper represents a Preliminary Conceptual Model (PCM), developed and used for episode selection for initial eight-hour modeling. A conceptual model profiles or typifies the meteorological conditions during which high levels of ozone are created for a region through the study of the meteorology accompanying high levels of ozone. The days which will comprise the modeling episode are specifically chosen because they reflect the area’s meteorology during the formation of high ozone levels. Thus, a successful PCM will supply an identification of the best time periods for the modeler to incorporate into a photochemical model in order to evaluate control strategies. An interim conceptual model includes modifications made to the PCM during the development of the modeling protocol and base case modeling. The refined conceptual model will be developed after initial modeling has been completed and control strategies have been implemented [2].

The San Antonio area episode(s) will include days during which measured ozone levels exceed the 8-hour average ozone NAAQS concentration standard of 85 parts per billion (ppb). If during a single day it is found that the 8-hour average ozone level is 85 ppb or above, while meteorological conditions are unexceptional, special notice of that day is taken. When several such days occur in a series, that set of days is a photochemical model episode candidate. The process undertaken for identification of such episodes in the San Antonio region, the analysis of the candidate episodes, and the rationale for their final ranking and selection are the subject of this report.

[1] Pg 18 of 168, "DRAFT GUIDANCE ON THE USE OF MODELS AND OTHER ANALYSES IN ATTAINMENT DEMONSTRATIONS FOR THE 8-HOUR OZONE NAAQS," EPA-454/R-99-004, May 1999. Online: http://www.epa.gov/ttn/scram/draft8hr.zip

[2] Page 2, "Development of a Conceptual Model for Episode Selection of High Eight-Hour Ozone Events in the Dallas / Fort Worth area," C. Durrenberger, P. Breitenbach, J. Red, D. Sullivan, S. Minto, TNRCC

PRELIMINARY CONCEPTS

CAMS in the San Antonio Region

There are currently four air quality monitors in the San Antonio region that record ozone levels reported to the public. The data from these sites are archived and displayed on the Internet[3] by the Texas Natural Resource Conservation Commission (now known as the Texas Commission on Environmental Quality), and is quality-assured to EPA standards. The monitoring equipment sets within this network are called CAMS, which is an acronym for Continuous Air Monitoring Station[4]. Information about San Antonio CAMS sites is contained in the table below, Table A-1. Figure A-1, on the following page, shows the locations of the local monitoring sites.

Notice that CAMS07 was deactivated on August 11, 1998 and CAMS58 was activated on August 12, 1998; the monitoring equipment located at CAMS07 was moved to its present location at CAMS58. Notice also that only CAMS23 has been active during the entire 1997, 1998 and 1999 ozone seasons; data from this monitor will be critical to any change in designation under the 8-hour ozone NAAQS.

Table A-1. Ozone-Recording CAMS sites in the San Antonio (SA) Airshed

CAMS Designation / Site Name	**Address; Location Description**	**Data Measured**	**First date of data reporting (online); maintained by**
CAMS23 / Marshall High School	6655 Bluebird Lane; northwestern SA	Ozone, Weather	Since September 17, 1996; TNRCC
CAMS58 / Camp Bullis	Near Wilderness road; far northern SA	Ozone, Weather and NOx	Since August 12, 1998; TNRCC
CAMS59 / Calaveras Lake	14620 Laguna Road; southeastern San Antonio	PM 2.5, NOx, Ozone, and Weather	Since May 13, 1998; University of Texas at Austin
CAMS678 / CPS/Trinity	802 Pecan Valley Dr.; near eastern San Antonio	CO, SO_2, NOx, Ozone, and Weather	Since March 4, 1999; by Trinity Consultants for CPS
CAMS07 / San Antonio North C07	522 Pilgrim Dr.; near northern San Antonio	CO, NOx, Ozone, and Weather	Deactivated on August 11, 1998

In addition to various pollutant readings, the weather data reported from each of these sites include location-specific temperature, wind direction and wind speed. This data is reported online as hourly-averaged values. Since promulgation of the 8-hour ozone NAAQS in 1997, eight-hour ozone reading averages are available online as well.

As mentioned in the Introduction, the 8-hour average concentration of 85 ppb for ozone is the single most important air quality measurement for San Antonio. According to the NAAQS, this critical threshold value determines whether an area is or is not in attainment of the 8-hour standard. If the average of the annual fourth-highest eight-hour average for three consecutive years is at or above 85 ppb at any one monitor, that region is not in attainment of the NAAQS.

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[3] "Air and Water Monitoring," on-line August 3, 2000: http://www.tnrcc.state.tx.us/air/monops/
[4] "What is a CAMS?", http://www.tnrcc.state.tx.us/cgi-bin/monops/daily_info?cams

Figure A-1. Monitoring locations in the San Antonio airshed.

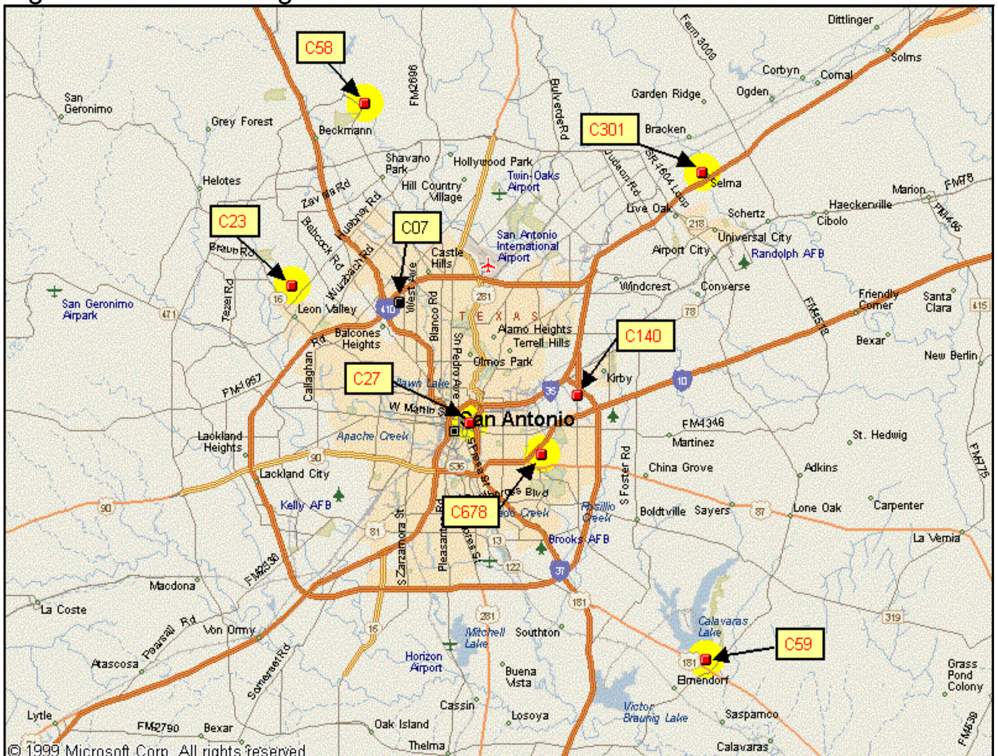


Image courtesy of TNRCC[5]. In addition to the ozone monitors discussed, this image shows C140 (weather only), C301 (PM 2.5 only) and C27 (CO and NOx only) CAMS sites.

Design Value

Another useful statistic is the design value. In the San Antonio area, the current design value is 88 ppb, the average of the annual fourth-highest ozone readings recorded at CAMS 23 (Marshall High School) during the 1997, 1998, and 1999 ozone seasons. The effectiveness of control strategies in helping a region to regain attainment is measured against this value. Also, when selecting episode days, the EPA recommends that daily peak ozone 8-hour averages be generally within 10 ppb above the 8-hour design value[6]. The design value will be discussed further in the section treating Episode Selection.

[5] http://www.tnrcc.state.tx.us/cgi-bin/monops/select_month?region13.gif
[6] Conversation with Pete Breitenbach, TNRCC, August 18, 2000

ELEMENTS OF THE CONCEPTUAL MODEL

A conceptual model identifies meteorological conditions that occur during days of excessive ozone formation. A high ozone day is classified as a day during which an ozone level of 85 ppb or above, when averaged for an eight-hour period, or 125 ppb or above for a one-hour averaging period, is recorded. Such levels exceed NAAQS air quality standards. Days during which such levels are achieved are also called exceedance days, and are candidate days for inclusion in a modeling episode. (While the one-hour average ozone NAAQS carries the 125 ppb one-hour average standard, San Antonio is currently at risk to lose only the attainment status for the 8-hour standard.)

Local Monitored Data

Seasonal Patterns of High Ozone Occurences

After compiling a list of these ozone exceedance days -- using both the one-hour and eight-hour definitions for exceedance -- from TNRCC's archives, the task of identifying patterns in the data begins. The meteorology determined for all exceedance days will, by definition, reflect all of the meteorological patterns that correspond to high ozone.

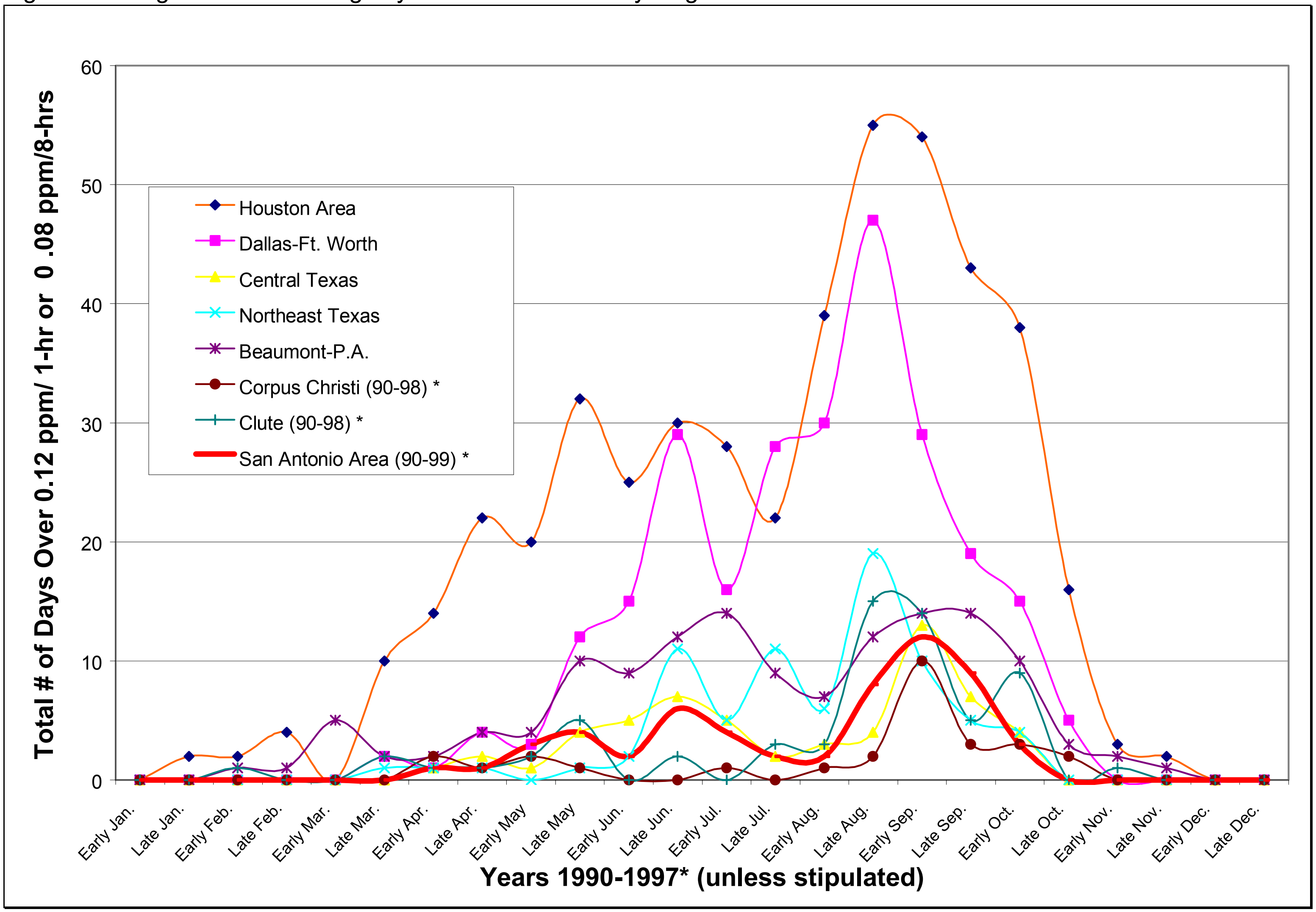
The ozone season for the region is seven months long, lasting from April to October. If, on a given day from 1990 to 1999, any monitor in the San Antonio region showed an exceedance for either the one-hour or the eight-hour ozone standard (125 ppb and 85 ppb, respectively), that day was counted. Such counts were totaled by two-week (half-month) periods and plotted in Figure 2. No day was counted more than once.

Within the ozone season, as shown in Figure A-2, there are two prominent periods during which the greatest number of exceedances occurred. Of the 57 exceedance days counted for San Antonio, 16 (28.1%) occurred between early May and late July. Also, 29 (50.9%) occurred between early August and late September.

This guides us in the first consideration. That is, we should further study episode candidates associated with each of these two periods within the ozone season[7]. It will likely be advisable that one modeling episode be drawn from each period.

[7] In the more advanced conceptual model, the seasonal periods identified should be scrutinized for underlying patterns unique to each season; perhaps wind patterns are unique to that season in the target airshed. Wind patterns may indict transport sources. Or perhaps there are sources identifiable within the emissions inventory which follow seasonal activity patterns. In both cases, such identification may lead to season-specific control strategies. In brief, ozone day occurence patterns identified according to season hint at further underlying factors affecting ozone formation. Marking the patterns by the calendar is not important; identifying the causes underlying the temporal distribution of occurences is important.

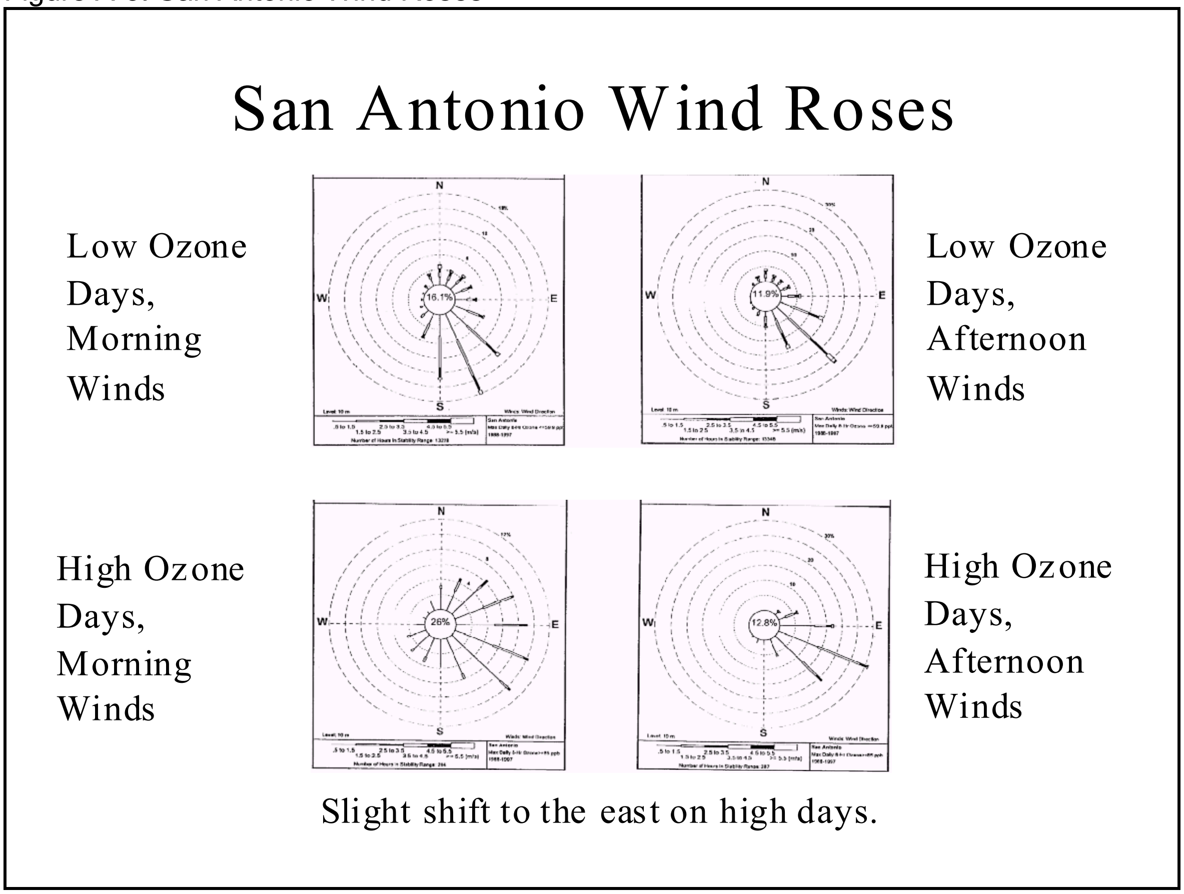
Figure A-2. High Ozone Readings by Two-Week Period by Region.



Local Wind Patterns: Monitoring Station Data

As prepared by TNRCC data analysis staff, the following figure, Figure A-3, shows the wind patterns associated with days of both low and high levels of ozone formation. This is a compilation of days within the ozone seasons (April 1 through October 31) from 1988 to 1997. The CAMS morning wind velocities (direction and speed) are averaged between 7:00 hours through 10:59 hours Central Standard Time (CST), inclusive. The afternoon wind velocities are averaged between 13:00 and 16:59 CST, inclusive. The averages shown are from 5 minute averages taken at all CAMS stations, averaged together.

Figure A-3. San Antonio Wind Roses



This graph shows that, during low ozone days, 16.1% of the velocity readings in the morning are light and variable (wind speed < 0.5 meters per second), while the direction for the morning winds are from the south, southeast or southeasterly. In contrast, during high ozone days, 26% of the velocity readings in the morning are light and variable, while the morning winds shift to the east.

In the same manner, during low ozone days, the image shows that 11.9% of the velocity readings in the afternoon are light and variable, while the direction for the afternoon winds are from the southeast. During high ozone days, 12.8% of the velocity readings in the afternoon are light and variable, while the afternoon winds shift to the east again.

This provides evidence of the wind directions one should anticipate seeing at the monitors when scrutinizing meteorological data for candidate episode days. However, just as the ozone season could be narrowed to the two periods within which one may select representative episodes, the Hysplit model will allow a refinement to the description of wind directions and speeds beyond the monitored, station-specific weather data.

Regional Modeling Data

The HYSPLIT Model

The Texas Natural Resource Conservation Commission (TNRCC) recommends back trajectory analysis as the preferred method in obtaining data necessary to track air parcels. Given a final geographic destination for an air parcel, back trajectories show the path followed by the parcel before reaching the destination. Theoretically, back trajectories effectively track air displacement over time, distance, and, consequently, over emission source areas.

The TNRCC recommends use of the HYSPLIT model to develop back trajectories. The Air Resources Laboratory of the National Oceanic and Atmospheric Administration (NOAA) maintains the HYSPLIT model. It is available for public use on the Internet at their Realtime Environmental Applications and Display sYstem (READY) webpage[8]. This versatile model can be run either as a trajectory (parcel displacement) or air dispersion model, using either forecast or archived meteorological data. The necessary data for creating the back trajectories used in this conceptual model development is linked to the online model. Point and click operation of the online model requires minimal data input by the user. While the meteorological database is not inexhaustible, the model and database is applicable across the United States, which provides a national reference for air trajectory and dispersion modeling needs.

Regional Wind Patterns: Back Trajectories

Earlier, the list of exceedance days was used to identify the annual periods during which ozone exceedance days frequently occurred, on a seasonal basis. That is, temporal patterns were identified for exceedance days. The HYSPLIT model is first used to estimate air parcel paths typical to ozone exceedance days. By running back trajectories for thirty-two of forty exceedance days in the San Antonio area from 1993 to 1996, TNRCC staff identified spatial patterns for exceedance days, shown in Figure A-4.

[8] READY Homepage: http://www.arl.noaa.gov/ready.html . Online August 3, 2000.

Figure A-4. Typification of Air Parcel Paths Arriving in San Antonio, Ozone Exceedance Days 1993 - 1998

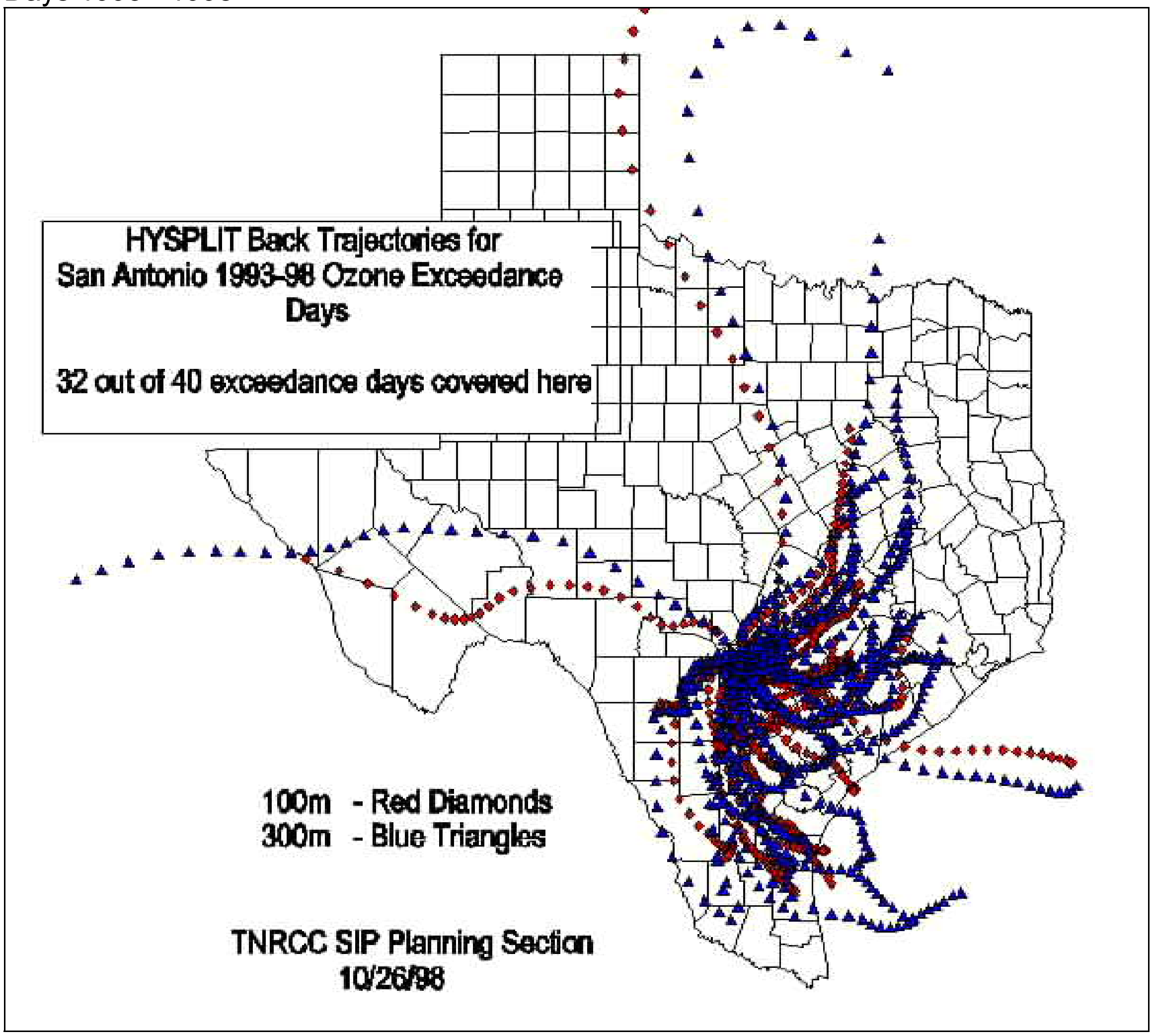
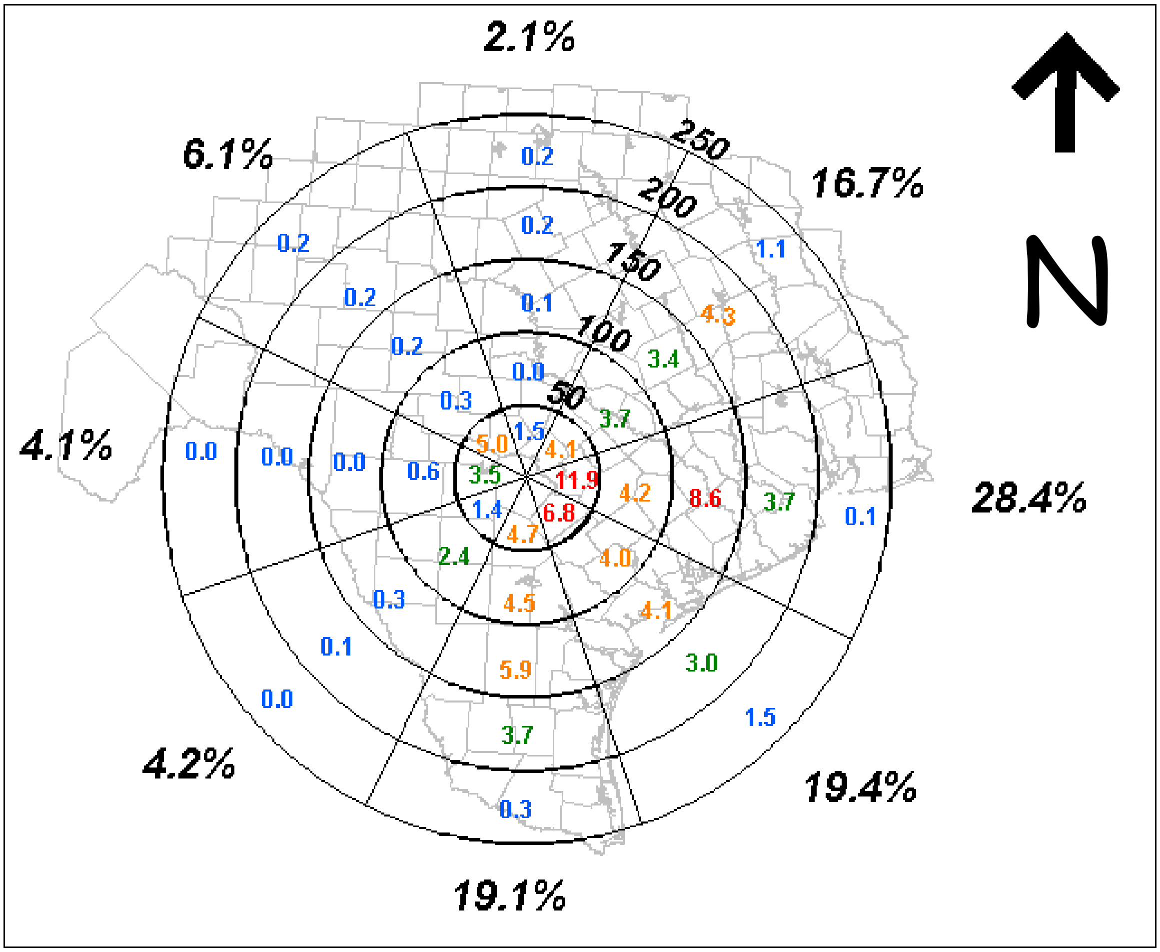


Figure A-4 shows the pattern of air parcel positions on their path to the San Antonio International Airport. The HYSPLIT model produces air parcel positions for every hour in the model run by latitude and longitude. Figure 4 shows that, on high ozone days, it is rare that air arriving in San Antonio will have come from the northwest or the southwest.

A quantitative refinement of the above data is presented next. In Figure A-5, the air parcel back trajectory locations have been sorted into bins and counted. More specifically, the region of central Texas within a 250 mile radius of the San Antonio International Airport (SAIA) has been partitioned into octants; northern, northeastern, eastern, southeastern, etc. Then, the region has been further subdivided by distance boundaries; area within 50 miles of SAIA, 50 to 100 miles of SAIA, etc., out to 250 miles from SAIA. Next, a count of the air parcel locations that fall in each bin were made, as they are given in the HYSPLIT model output files. Finally, these raw counts were converted into percentages and written into the representative bins. Note that the percentages in bold font outside of the 250 mile boundary are sums of the percentages within the octant. That is, for example, the image shows that 3.5% of the air parcel passed to the west and within 50 miles of SAIA; 0.6% passed to the west and between

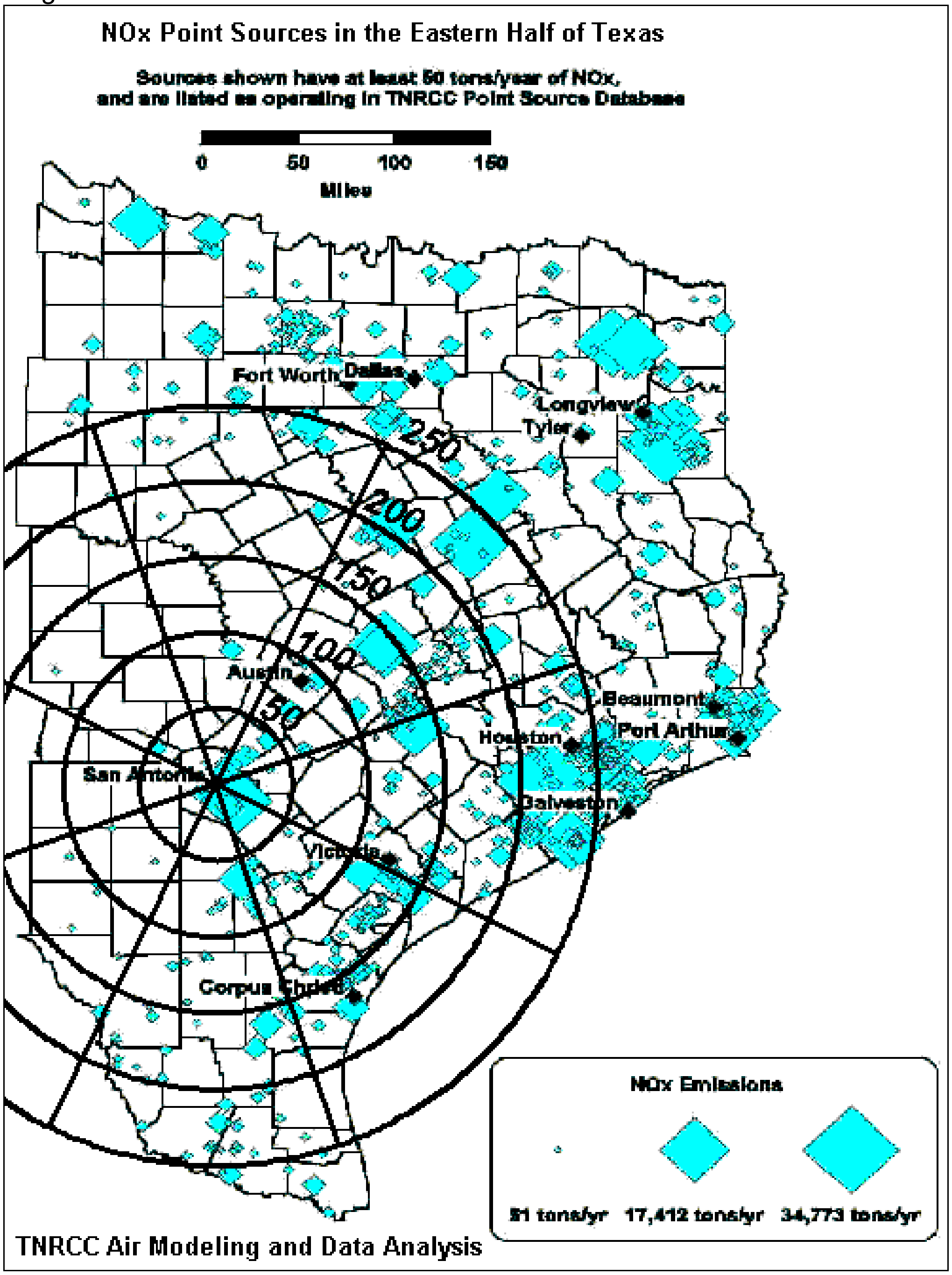
50 and 100 miles of SAIA. Due west of SAIA, outside the 250 mile boundary, the figure in bold, 4.1%, indicates the sum of all air parcels that passed to the west of SAIA within the western octant.

Figure A-5. Back Trajectories Percentages by Direction for High Ozone Days, 1993-1998



This is extremely valuable information. Just as the exceedance day list was used to identify the temporal occurrence of exceedance days, this calculation shows clearly how frequently air parcels passed through a given region, by distance and direction (octant), before coming to San Antonio on a high ozone day. Industrial (point) sources can be identified within the zones delineated in the image. Figure A-6 presents NOx Point Sources in the Eastern Half of Texas by their distance, magnitude and direction from San Antonio.

Figure A-6. NOx Point Sources in the Eastern Half of Texas by their distance, magnitude and direction from San Antonio.



Now that the seasonal time periods and typical air movements prior to ozone exceedances in the San Antonio region have been identified, the exceedance day information must be reviewed. The preceding statistical work has allowed identification of particular meteorological parameters which candidate episodes must fulfill. Episodes must have winds from the south, southeast, east and northeast. Episodes should be chosen from the two annual periods for exceedances: May to early July, and late August to late September. Depending on episode selection availability, air parcels traveling through the eastern octant, where some of the larger point sources are found, may weigh favorably on episode selection. Next, the exceedance day data will be reviewed for formation of candidate episodes.

EPISODE SELECTION

Episode Candidates: Exceedance Days

San Antonio does not have many episode candidates, simply because San Antonio ozone levels are not typically excessive. The following table (A-2) lists all eight-hour ozone exceedance days recorded in San Antonio for ozone seasons 1995 through 1999. While the one-hour high values for the same days are listed, not every eight-hour exceedance day is a one-hour exceedance day. In fact, only three one-hour exceedances (one of which was excused by EPA) exist on these records. Every one-hour exceedance is listed.

The years 1995-1999 alone are listed, since earlier years are not considered feasible for emission inventory and photochemical modeling development. A preference is placed on modeling 1997 and more recent years, since these are the years during which the 8-hour ozone NAAQS has been in effect. Note also that the column heading "Episode Dates" refers either to existing modeling episode dates -- in which case ramp-up days are included in the episode dates listed -- or refers to the episode candidate period marked exclusively by exceedance days. In the latter case, ramp-up days, which are negotiable but are not part of the analysis considered here, are not included in the episode date period listed.

Table A-2. 1995-1999 Ozone Exceedances and Possible Modeling Episodes for the AACOG Region: Ozone Readings from San Antonio Region Monitors

1995 Ozone Exceedance Days

	1 Hour	8 Hour	Episode Dates	Notes
6/13/95	*105*	*96*		
6/21/95	*100*	*93*	June 18-22	Existing UT Episode
6/22/95	*97*	*85*		
6/23/95	*111*	*89*		
6/27/95	*105*	*86*		
7/8/95	*109*	*87*	July 7-12	Existing AACOG Episode
7/9/95	*99*	*87*		
7/11/95	*109*	*86*		
9/3/95	*120*	*104*	August 31-September 3	Existing TNRCC Episode
9/9/95	*105*	*94*		
9/10/95	*108*	*91*		
9/25/95	*119*	*108*		
9/26/95	*122*	*101*		
10/10/95	*108*	*90*		

1996 Ozone Exceedance Days

	1 Hour	8 Hour	Episode Dates	Notes
6/3/96	*130*	*97*	No Modeling Episode	Not sufficient ozone exceedances for a 1996 modeling episode
7/3/96	*106*	*89*		

1997 Ozone Exceedance Days

	1 Hour	8 Hour	Episode Dates	Notes
7/16/97	*123*	*95*	No Modeling Episode	Not sufficient ozone exceedances for a 1997 modeling episode
8/26/97	*103*	*95*		
9/6/97	*100*	*88*		

1998 Ozone Exceedance Days

	1 Hour	8 Hour	Episode Dates	Notes
5/7/98	*140*	*101*	No Modeling Episode	Mexican Forest Fires; excused by EPA
5/10/98	*107*	*89*		
8/28/98	*99*	*89*	August 28 - September 3	
8/30/98	*99*	*92*		
9/3/98	*105*	*87*		
9/4/98	*141*	*110*	No Modeling Episode	
9/16/98	*107*	*91*		
10/9/98	*121*	*95*		

1999 Ozone Exceedance Days

	1 Hour	8 Hour	Episode Dates	Notes
8/5/99	*120*	*100*		
8/16/99	*109*	*87*	August 16-21	
8/21/99	*109*	*87*		
8/30/99	*101*	*85*	August 30-September 1	
8/31/99	*108*	*95*		
9/1/99	*109*	*91*		
9/16/99	*93*	*85*	September 16 – 20	
9/18/99	*108*	*96*		
9/19/99	*96*	*91*		
9/20/99	*107*	*86*		
10/1/99	*99*	*88*		

Requirements Limiting Episode Selection

One criterion for episode selection is that there be more than two exceedance days in the episode. In all, the episode should be between three to ten days[9] or so. Due to the expense and time required to model episodes, it is not practical to model all episode days. With these introductory guidelines in mind, reinforced by the desirability of developing 1997-1999 episodes, there are no episode candidates in 1995, 1996 or 1997, although June 21-23, 1995 are three exceedance days for San Antonio. This is not a strong candidate since the period is in 1995. This consideration tends to exclude August 16-21, 1999 in which only two exceedance days appear.

Note also that on September 4, 1998, a one-hour ozone high of 141 ppb and an eight-hour ozone high of 110 were recorded (both at CAMS 58). This day comes at the end of an episode candidate, the August 28 - September 3, 1998 period. Exceedance days within 10 ppb above the design value of 88 ppb are preferred. The September 4th 8-hour

[9] Page 2, "Development of a Conceptual Model for Episode Selection of High Eight-Hour Ozone Events in the Dallas / Fort Worth area," C. Durrenberger, P. Breitenbach, J. Red, D. Sullivan, S. Minto, TNRCC

average value of 110 ppb is 22 ppb above the design value. This high value tends to exclude September 4th from consideration as part of the August 28 - September 3 episode. The high values for both the one- and eight-hour averages recorded on September 4th represent an anomaly and are the highest in this record set. On the other hand, if the August 28 - September 3, 1998 period is valuable as a modeling episode, it is within the modeler's discretion to note the anomaly and choose to include September 4 in the episode. It may be of interest to note the response of the model on this day to the control strategies considered. Also, since this exceedance comes as the very last day in an episode, there is no following exceedance day. There might be conceivably be debate about the value of an episode with such an anomaly surrounded by other exceedance days.

A restriction on episode selection has arisen since some meteorological data is missing. At this time, Eta Data Assimilation System (EDAS) data is unavailable to create the meteorological modeling required for the August 30 - September 1, 1999 candidate episode[10]. There are no current plans to replace this data. Coarse grid data exists which may be used to interpolate the missing data, but this is not a preferred methodology and would require additional expense. The August 30 - September 1, 1999 candidate episode is effectively removed from consideration for this time.

Other data is missing from the same data set. Due to a fire at the National Weather Service's National Centers for Environmental Prediction (NCEP) computer facility at the end of September 1999, EDAS data was not produced between October 1 and November 4, 1999. There currently are no plans to reproduce the missing EDAS data[11]. EDAS data is used both by the HYSPLIT model and to create the meteorological input files to the photochemical model.

With the above considerations in mind, August 16-21, 1999 and August 30-September 1, 1999 are excluded. A list of two candidate episodes can be defined. They are presented in Table A-3 below.

None of the one-hour daily highs are within 15 ppb of the one-hour threshold of 125 ppb. The highest of the eight-hour averaged daily high values, 96 ppb for September 18, 1999, is eight ppb above the design value of 88 ppb. That is, none of the values in the remaining candidate episodes are excessively elevated, but rather are near the design value. This is fortunate, since very elevated daily high values are anomalies to be avoided, as are the rare events previously discussed. These eight-hour values are within 10 ppb above the design value, as discussed in Section 2.0.

[10] EDAS data is missing for August 29 at 15Z - 21Z and August 30 at 00Z. Conversation with Pete Brietenbach and Shannon Minto, TNRCC, August 15, 2000.

[11] According to "HYSPLIT4 ARCHIVE TRAJECTORIES," http://www.arl.noaa.gov/ready-bin/traj1file.pl

Table A-3. Candidate Ozone Episodes

1998 Ozone Exceedances

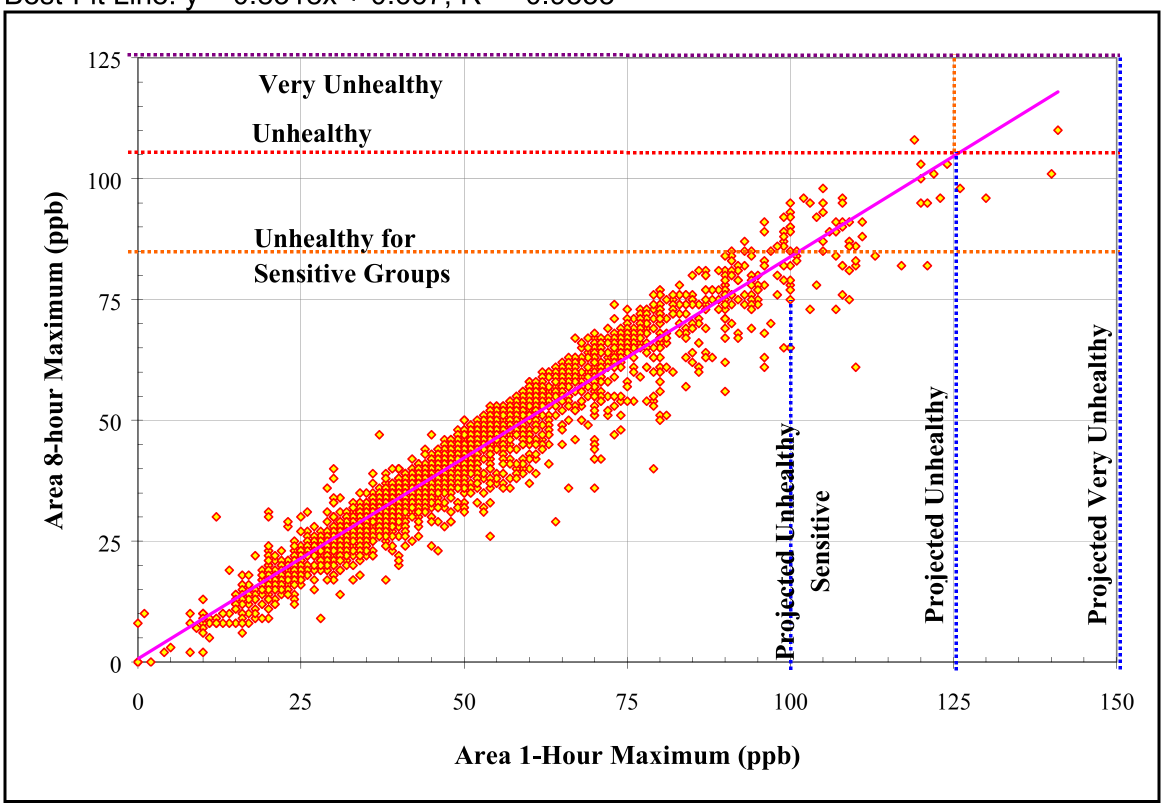
	1 Hour Daily High	8 Hour Daily High	Modeling Episode Dates w/o Ramp Up	# Days Required to model, including Start-to-End Dates	Modeling Episode Dates with 3 Ramp Up Days	# Days Required to model
8/28/98	*99*	*89*	August 28 - September 3	7	August 25 - September 3	10
8/30/98	*99*	*92*				
9/3/98	*105*	*87*				

1999 Ozone Exceedances

9/16/99	*93*	*85*	September 16 - 20	5	September 13 - 20	8
9/18/99	*108*	*96*				
9/19/99	*96*	*91*				
9/20/99	*107*	*86*				

A closely-related consideration is the relationship between high one-hour averages and high eight-hour averages. The following figure, Figure A-7, shows the close correlation between high one- and eight-hour values for 1990 through 1999. This graph was prepared by TNRCC staff meteorologists.

Figure A-7. San Antonio Area Maximum Ozone 1990-1999
Best-Fit Line: $y = 0.8318x + 0.667$; $R^2 = 0.9353$



The best-fit line for the data has an R^2 value of 0.9353, an indication that the correlation between one- and eight-hour data is generally high. The table below, Table A-4, gives the comparison between the best-fit line equation and the observed values recorded in Table A-3.

Table A-4. Observed and Predicted values correlated with Best Fit line, 1990-1999

	Observed 1 Hour Daily High	Observed 8 Hour Daily High	Predicted 8-hour high, based on y=0.8318*x + 0.667	Observed - Predicted
1995				
	July 8, 9, 11, 1995 - **Existing AACOG Photochem. Model Episode Exceedance Days**			
7/8/95	109	87	91.3332	-4.332
7/9/95	99	87	83.0152	3.9848
7/11/95	109	86	91.3332	**-5.3332**
1998				
	August 28 - September 3, 1998			
8/28/98	99	89	83.0152	5.9848
8/30/98	99	92	83.0152	**8.9848**
9/03/98	105	87	88.006	-1.006
9/04/98	*141*	*110*	*117.9508*	*-7.9508*
1999				
	September 16 - 20, 1999			
9/16/99	93	85	78.0244	6.9756
9/18/99	108	96	90.5014	5.4986
9/19/99	96	91	80.5198	**10.4802**
9/20/99	107	86	89.6696	**-3.6696**

The correlation between the best fit line itself and the one- and eight-hour observed values is poorest for September 19, 1999 and August 30, 1998. Underlying these differences is an unusually-long sustained ozone level, near in value to the day's highest one-hour value, during the eight hours used in the eight-hour averaging period for that day. This lifts the day's corresponding eight-hour averages above the best-fit line, that is, nearer the numerically higher one-hour value itself, on those two days.

In contrast, the difference (negative) between observed and predicted values on September 20, 1999, show that the one-hour value "spiked;" the low eight-hour average of 86 ppb required much lower values in the set to bring the one-hour high of 107 ppb down in the average. Yet, as can be seen from the data within the existing AACOG photochemical model episode, July 11, 1995 shows an even more pronounced "spike." (The September 4, 1998 values, included here in italics, for the sake of comparison, show this relationship.)

Judging from the acceptability of the existing 1995 modeling episode, the September 20, 1999 value is acceptable as well. In all, the differences reported above are not seen as valid reasons for disqualifying the 1998 and 1999 episode days from further consideration.

Staff produced one-hour versus eight-hour plots, like Figure 5, for 1995, 1996, 1998, and 1999. The results are provided in Figures A-8 through A-11, respectively.

Figure A-8. 1995 San Antonio 1hr - 8hr Ozone Regression

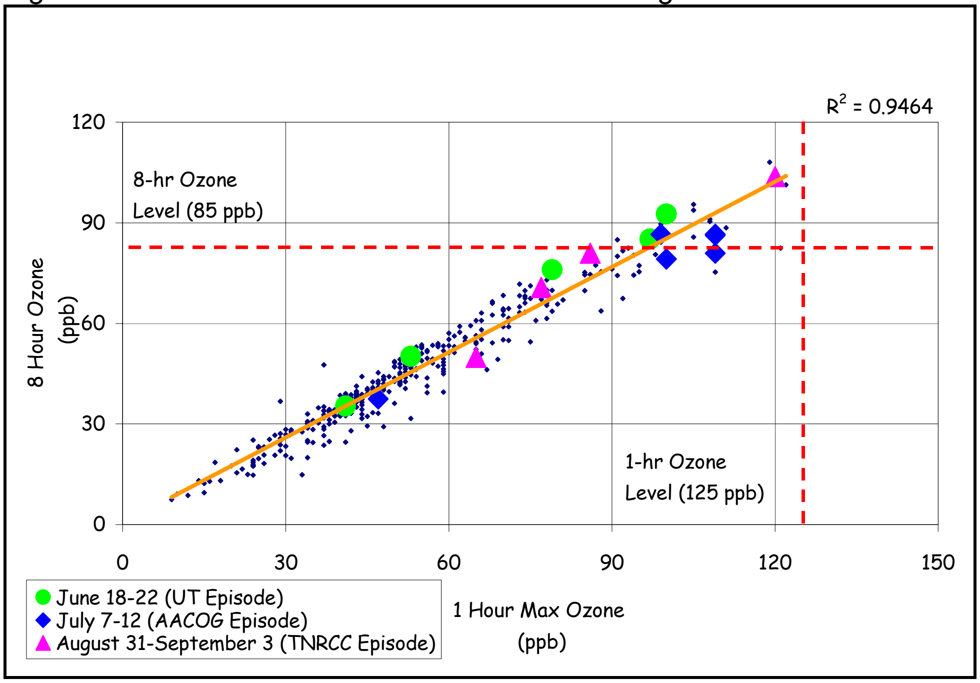


Figure A-9. 1996 San Antonio 1hr - 8hr Ozone Regression

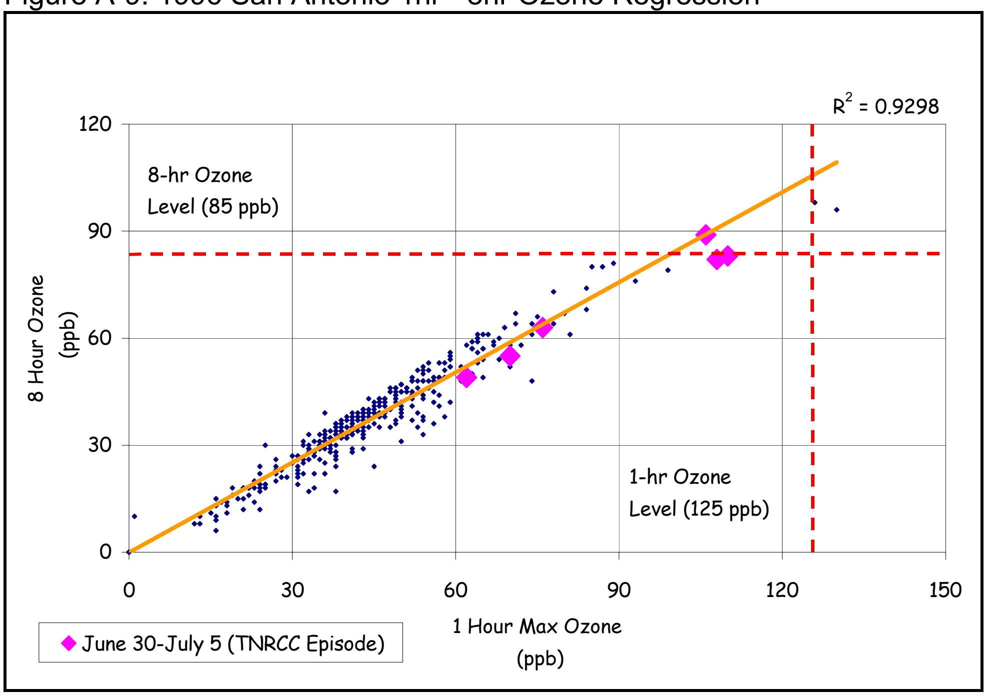


Figure A-10. 1998 San Antonio 1hr - 8hr Ozone Regression

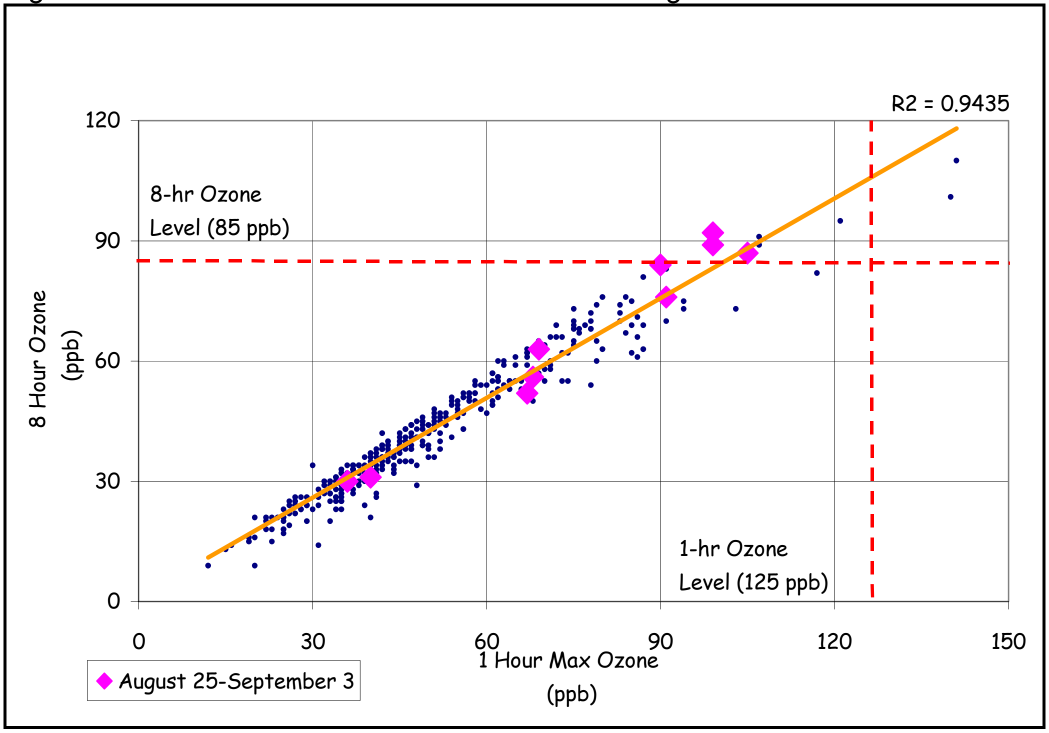
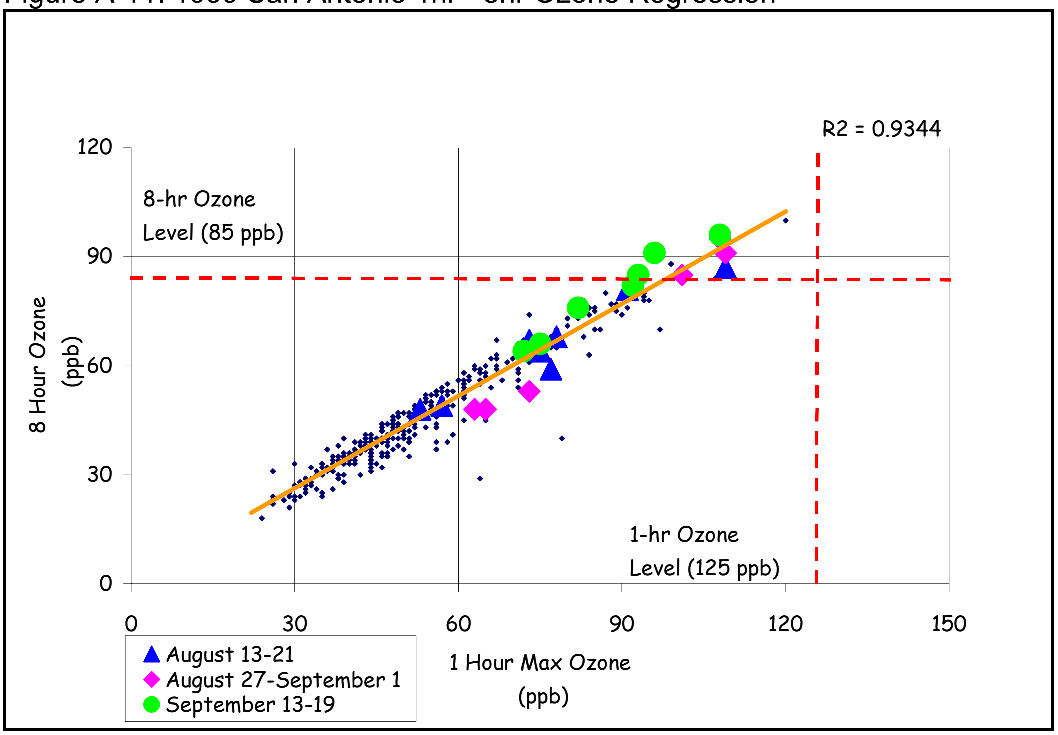


Figure A-11. 1999 San Antonio 1hr - 8hr Ozone Regression



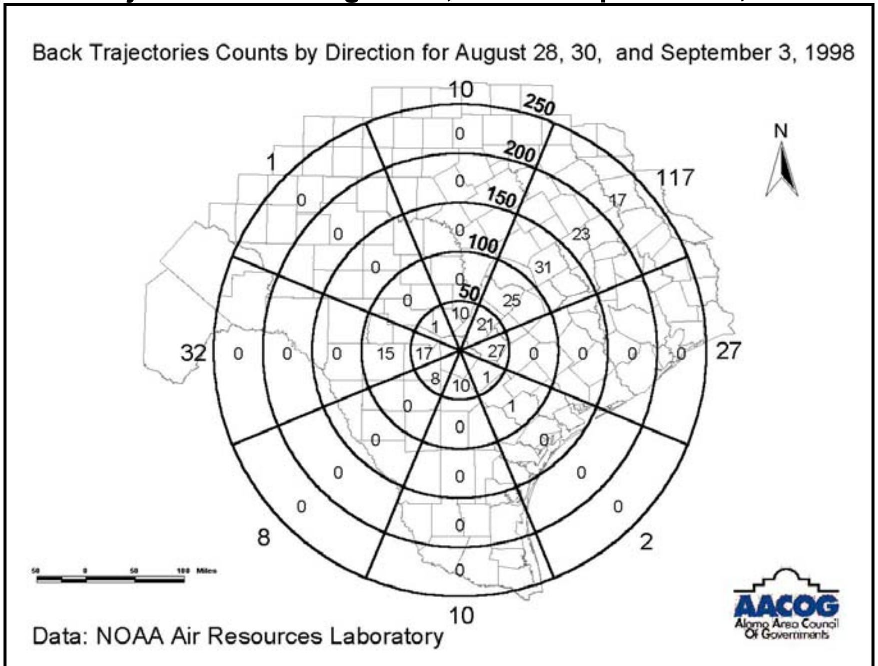
Comparison of Back Trajectories

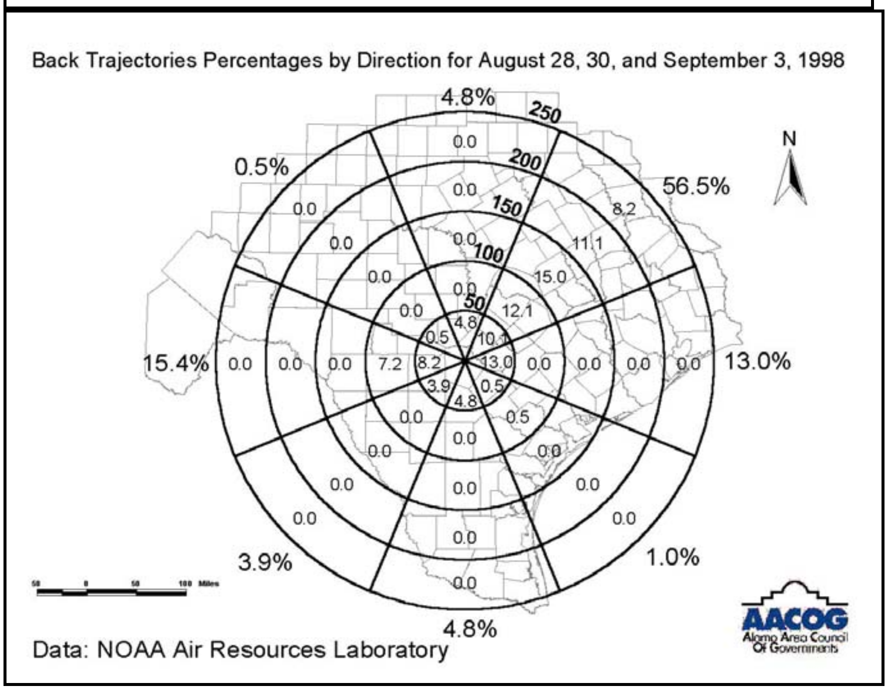
The following comparison between the Back Trajectories for the 1993-1998 High Ozone Days, the existing 1995 Photochemical Model Episode, and the 1998 & 1999 Episode Candidates begins the final analysis of the wind trajectories. Figure 5 shows the direction (by octant) and distance of the air parcel trajectories from 1993 through 1998 for all high ozone days. The distribution of air parcel locations in the northeast, east, southeast and southern octants represents 83.6% of the total high ozone day air parcel locations for the entire six year period. In a sense, the goal for this section of the conceptual model development is to incorporate back trajectories for the exceedance days found in the existing 1995 photochemical model together with one or more of the candidate episodes such that the resulting combination generally matches the distribution of the 1993-1998 back trajectory set.

Each exceedance day of the two candidate episodes (not including ramp-up days), August 28, 30 and September 3, 1998, and September 16, 18 - 20, 1999, was run through the Hysplit model to determine a back trajectory. In all cases, the back trajectory ended at the San Antonio International Airport at 21 UTC (4 p.m., Central Standard, Daylight Savings time), with the exception of one day: August 31, 1998. The back trajectory ended at 12 UTC (7 a.m.) instead. This was necessary due to missing EDAS data required in the Hysplit model. For the same reasons, all back trajectories were 33 hours except for August 28, 1998 (19 hours), and September 3, 1998 (19 hours).

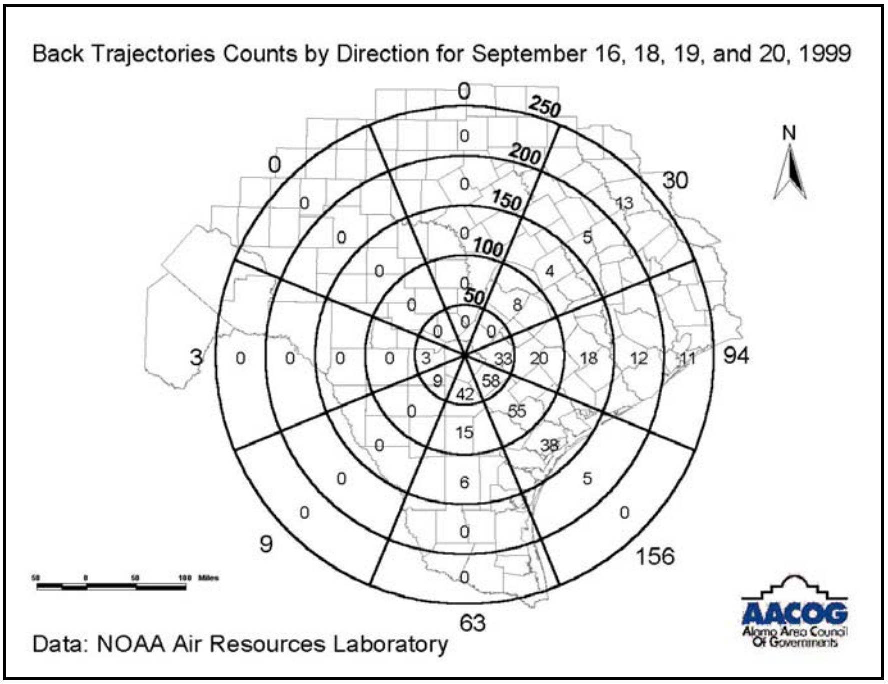
By entering the data from the Hysplit model as input to GIS software (ARC INFO), the following graphs were developed. They indicate air parcel positions for each of the episodes. Graphs showing both raw position counts given by the Hysplit model and percentages of the total are given.

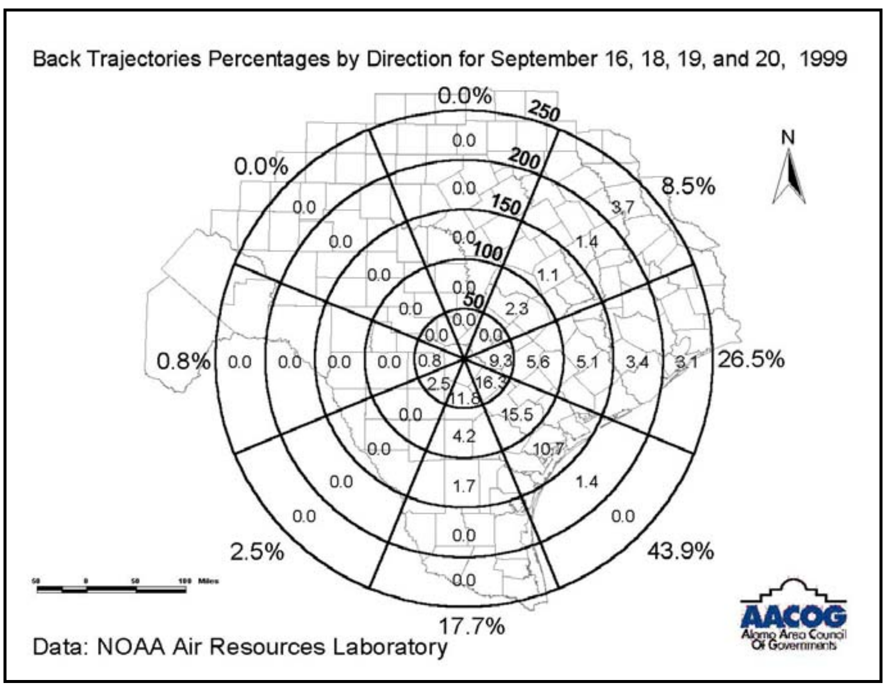
Back Trajectories for August 28, 30 and September 3, 1998





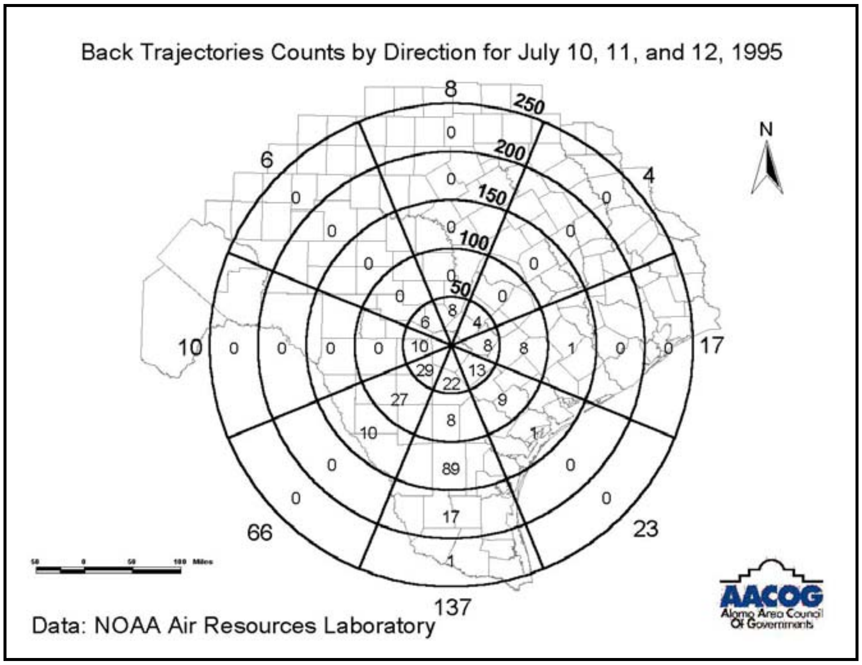
Back Trajectories for September 16, 18, 19 and 20, 1999

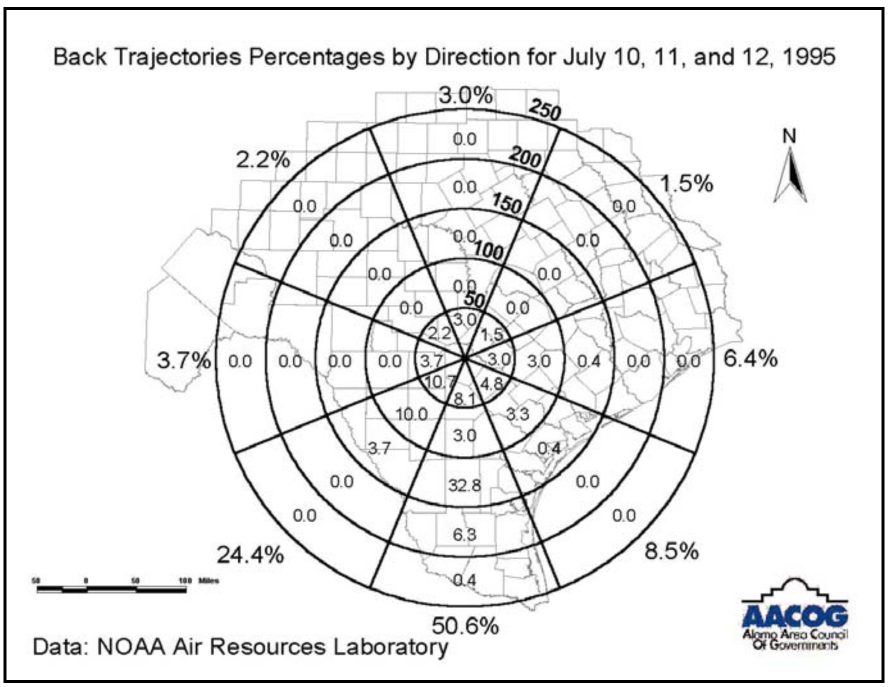




In addition, the back trajectories were calculated for the AACOG Photochemical model days currently used for analysis, July 10 - 12, 1995. The resulting analysis is contained in the graphs below.

Back Trajectories for July 10 - 12, 1995





Note that the air parcel trajectories associated with the 1995 AACOG Photochemical Modeling episode are essentially (75%) all within the southern or southwestern octant. As shown in Figure A-5, very few trajectory positions in the 1993-1998 trajectory sum were in the southwestern octant; the southwestern octant need not be well-represented by the modeling episodes. Ideally, a second modeling episode candidate would provide the missing back trajectories required in Figure A-5 for the southeastern, eastern and northeastern octants. Back trajectories filling the northeast, east, and southeast octants are required in a 16.7/28.4/19.4 ratio, or, roughly, an equivalent ratio of 26/44/30. The following table, A-5, presents a comparison of the counts and percentages in these three quadrants, by episode.

Table A-5. Comparison of Back Trajectories without 1995 AACOG episode

	#, % of all Trajectory Points in NE, E, SE	% Trajectory Points in Northeast	% Trajectory Points in East	% Trajectory Points in Southeast	Ratio NE/E/SE
1993-1998 Back Trajectories	565, 64.5%	16.7%	28.4%	19.4%	26 / 44 / 30
Aug 28, 30 Sept 3, 1998	146, 70.1%	56.5%	13%	1%	80 / 19 / 1
Sept 16, 18 - 20, 1999	280, 78.9%	8.5%	26.5%	43.9%	11 / 36 / 56

The 1998 scenario contains many trajectory points in the northeast octant. The September 16 - 20, 1999 scenario ratio seems better balanced.

The next table, A-6, presents a similar comparison of the four major octants which must be accounted for. Here, the candidate episode trajectories are combined with the Base Case 1995 AACOG Photochemical Model (BC) to compare with the 1993 - 1998 trajectory data. Because the attainment modeling will use both episodes, the 1995 Base Case plus at least one additional episode, for demonstration purposes, this shows the combined effectiveness of multiple episode considerations.

Table A-6. Comparison of Back Trajectories with 1995 AACOG episode

	#, % of all Trajectory Points in NE, E, SE, S	% Trajectory Points in Northeast	% Trajectory Points in East	% Trajectory Points in Southeast	% Trajectory Points in South	Ratio NE/E/SE/S
1993-1998 Back Trajectories	732, 83.6%	16.7%	28.4%	19.4%	19.1%	20 / 34 / 23 / 23
Aug 28, 30 Sept 3, 1998 + BC	337, 70.5%	25.3%	9.2%	5.3%	30.8%	36 / 13 / 8 / 44
Sept 16, 18 - 20, 1999 + BC	524, 83.7%	5.4%	17.7%	28.6%	32%	7 / 21 / 34 / 38

Table A-6 shows that both combined episodes cover the four essential octants. This same data is presented in more detail in tables A-7 through A-9 below.

Table A-7. 1993 - 1998 Ozone Exceedance Days for San Antonio

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	13	0	1	2	2	18	2.05%
Northeast	36	32	30	38	10	146	16.67%
East	104	37	75	32	1	249	28.42%
Southeast	60	35	36	26	13	170	19.41%
South	41	39	52	32	3	167	19.06%
Southwest	12	21	3	1	0	37	4.22%
West	31	5	0	0	0	36	4.11%
Northwest	44	3	2	2	2	53	6.05%
	341	172	199	133	31	<= Counts	
	38.93%	19.63%	22.72%	15.18%	3.54%	<= Percent	

Table A-8. Base Case (July 10, 11, and 12, 1995) plus Aug 28, 30 Sept 3, 1998

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	18	0	0	0	0	18	3.77%
Northeast	25	25	31	23	17	121	25.31%
East	35	8	1	0	0	44	9.21%
Southeast	14	10	1	0	0	25	5.23%
South	32	8	89	17	1	147	30.75%
Southwest	37	27	10	0	0	74	15.48%
West	27	15	0	0	0	42	8.79%
Northwest	7	0	0	0	0	7	1.46%
	195	93	132	40	18	<= Counts	
	40.79%	19.46%	27.62%	8.37%	3.77%	<= Percent	

Table A-9. Base Case (July 10, 11, and 12, 1995) plus Sept 16, 18 - 20, 1999

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	8	0	0	0	0	8	1.28%
Northeast	4	8	4	5	13	34	5.43%
East	41	28	19	12	11	111	17.73%
Southeast	71	64	39	5	0	179	28.59%
South	64	23	95	17	1	200	31.95%
Southwest	38	27	10	0	0	75	11.98%
West	13	0	0	0	0	13	2.08%
Northwest	6	0	0	0	0	6	0.96%
	245	150	167	39	25	<= Counts	
	39.14%	23.96%	26.68%	6.23%	3.99%	<= Percent	

These tables show that the combined episode using August 28, 30 and September 3, 1998, weighs heavily in the Northeast octant (25.3% compared to 16.7% in the 1993 - 1998 set, a difference of 8.6%), while the combined episode using September 16, 18-20, 1999 is very light (5.4% to 16.7% -- a difference of 11.3%) in the same octant. Both combined episodes weigh heavily in the Southern octant (~31% to 19%). However, the 1998 episode is very light in the East (9.2% to 28.4% -- a difference of 19.2%) and the Southeast (5.2% to 19.4% -- a difference of 14.2%). The 1999 episode is better balanced in the East (17.7% to 28.4% -- a difference of 10.7%) and the Southeast (28.6% to 19.4% -- a difference of 9.2%). In this light, the September 16, 18-20, 1999 episode, combined with the Base Case set, does represent the required back trajectories marginally better than does the August 28, 30 and September 3, 1998 combined set.

Figure A-6 shows that large NOx Point Sources exist to the east of San Antonio. Many are based in the Houston / Galveston area. This also argues in favor of the September 16, 18-20, 1999 episode, which shows a greater percentage of eastern trajectories than does the August 28, 30 and September 3, 1998 trajectory set.

Combining the Base Case episode with the 1998 and 1999 episodes described above gives a good coverage of the required back trajectories. This is shown in table A-10 below. Compare these values with those in Table A-7.

Table A-10. Base Case (July 10, 11, and 12, 1995), Sept 16, 18 - 20, 1999 and Aug 28, 30 Sept 3, 1998

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	18	0	0	0	0	18	2.16%
Northeast	25	33	35	28	30	151	18.13%
East	68	28	19	12	11	138	16.57%
Southeast	72	65	39	5	0	181	21.73%
South	74	23	95	17	1	210	25.21%
Southwest	46	27	10	0	0	83	9.96%
West	30	15	0	0	0	45	5.40%
Northwest	7	0	0	0	0	7	0.84%
	340	191	198	62	42	<= Counts	
	40.82%	22.93%	23.77%	7.44%	5.04%	<= Percent	

The conclusion for this chapter is that, in consideration of the back trajectories provided by the HYSPLIT model and the point source locations, the September 16, 18-20, 1999 will be a preferable episode to model next. However, the same data set strongly argues for another episode, the August 28, 30 and September 3, 1998 period to follow. Recall that, according to Table A-3, the 1999 episode also would require a minumum of five days to model (excluding ramp-up days), while the 1998 episode would require seven days to model (also excluding ramp-up days). Thus the 1999 episode might be less expensive to model. A detailed trajectory count, both by combined and uncombined Hysplit runs, is provided in Table A-11.

Table A-11. Total and Episode-specific Trajectory Counts.
1993 - 1998 Ozone Exceedance Days for SA

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	13	0	1	2	2	18	2.05%
Northeast	36	32	30	38	10	146	16.67%
East	104	37	75	32	1	249	28.42%
Southeast	60	35	36	26	13	170	19.41%
South	41	39	52	32	3	167	19.06%
Southwest	12	21	3	1	0	37	4.22%
West	31	5	0	0	0	36	4.11%
Northwest	44	3	2	2	2	53	6.05%
	341	172	199	133	31	<= Counts	
	38.93%	19.63%	22.72%	15.18%	3.54%	<= Percent	

Base Case -- July 10, 11, and 12, 1995

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	8	0	0	0	0	8	2.95%
Northeast	4	0	0	0	0	4	1.48%
East	8	8	1	0	0	17	6.27%
Southeast	13	9	1	0	0	23	8.49%
South	22	8	89	17	1	137	50.55%
Southwest	29	27	10	0	0	66	24.35%
West	10	0	0	0	0	10	3.69%
Northwest	6	0	0	0	0	6	2.21%
	100	52	101	17	1	<= Counts	
	36.90%	19.19%	37.27%	6.27%	0.37%	<= Percent	

August 28, 30 and September 3, 1998

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	10	0	0	0	0	10	4.83%
Northeast	21	25	31	23	17	117	56.52%
East	27	0	0	0	0	27	13.04%
Southeast	1	1	0	0	0	2	0.97%
South	10	0	0	0	0	10	4.83%
Southwest	8	0	0	0	0	8	3.86%
West	17	15	0	0	0	32	15.46%
Northwest	1	0	0	0	0	1	0.48%
	95	41	31	23	17	<= Counts	
	45.89%	19.81%	14.98%	11.11%	8.21%	<= Percent	

August 30 - September 1, 1999

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	0	0	0	0	0	0	0.00%
Northeast	4	1	0	0	4	9	3.93%
East	51	43	14	7	0	115	50.22%
Southeast	60	25	18	2	0	105	45.85%
South	0	0	0	0	0	0	0.00%
Southwest	0	0	0	0	0	0	0.00%
West	0	0	0	0	0	0	0.00%
Northwest	0	0	0	0	0	0	0.00%
	115	69	32	9	4	<= Counts	
	50.22%	30.13%	13.97%	3.93%	1.75%	<= Percent	

September 16, 18 - 20, 1999

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	0	0	0	0	0	0	0.00%
Northeast	0	8	4	5	13	30	8.45%
East	33	20	18	12	11	94	26.48%
Southeast	58	55	38	5	0	156	43.94%
South	42	15	6	0	0	63	17.75%
Southwest	9	0	0	0	0	9	2.54%
West	3	0	0	0	0	3	0.85%
Northwest	0	0	0	0	0	0	0.00%
	145	98	66	22	24	<= Counts	
	40.85%	27.61%	18.59%	6.20%	6.76%	<= Percent	

A comparison may be made between the 1993 - 1998 ozone exceedance days data and combinations of the base case with various candidate episode data. These combinations (see Table A-12) help demonstrate that the back trajectories given by the combination of base case and various episodes will, to varying degrees, represent the back trajectories required to comprehensively represent the 1993 - 1998 ozone exceedance days trajectories. This represents one goal of the Conceptual Modeling exercise, identification of likely episodes according to the similarity of the candidate episode conditions -- in this case, wind trajectories -- compared to composite profile of high ozone days.

Table A-12. Back Trajectories Counts and Percentages, Combined Data

1993 - 1998 Ozone Exceedance Days for San Antonio

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	13	0	1	2	2	18	2.05%
Northeast	36	32	30	38	10	146	16.67%
East	104	37	75	32	1	249	28.42%
Southeast	60	35	36	26	13	170	19.41%
South	41	39	52	32	3	167	19.06%
Southwest	12	21	3	1	0	37	4.22%
West	31	5	0	0	0	36	4.11%
Northwest	44	3	2	2	2	53	6.05%
	341	172	199	133	31	<= Counts	
	38.93%	19.63%	22.72%	15.18%	3.54%	<= Percent	

Base Case (July 10, 11, and 12, 1995) plus Aug 28, 30 Sept 3, 1998

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	18	0	0	0	0	18	3.77%
Northeast	25	25	31	23	17	121	25.31%
East	35	8	1	0	0	44	9.21%
Southeast	14	10	1	0	0	25	5.23%
South	32	8	89	17	1	147	30.75%
Southwest	37	27	10	0	0	74	15.48%
West	27	15	0	0	0	42	8.79%
Northwest	7	0	0	0	0	7	1.46%
	195	93	132	40	18	<= Counts	
	40.79%	19.46%	27.62%	8.37%	3.77%	<= Percent	

Base Case (July 10, 11, and 12, 1995) plus Sept 16, 18 - 20, 1999

	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	8	0	0	0	0	8	1.28%
Northeast	4	8	4	5	13	34	5.43%
East	41	28	19	12	11	111	17.73%
Southeast	71	64	39	5	0	179	28.59%
South	64	23	95	17	1	200	31.95%
Southwest	38	27	10	0	0	75	11.98%
West	13	0	0	0	0	13	2.08%
Northwest	6	0	0	0	0	6	0.96%
	245	150	167	39	25	<= Counts	
	39.14%	23.96%	26.68%	6.23%	3.99%	<= Percent	

Base Case (July 10, 11, and 12, 1995), Sept 16, 18 - 20, 1999 and Aug 28, 30 Sept 3, 1998							
	0 - 50 Miles	50 - 100	100 - 150	150 - 200	200 - 250	Counts	Percent
North	18	0	0	0	0	18	2.16%
Northeast	25	33	35	28	30	151	18.13%
East	68	28	19	12	11	138	16.57%
Southeast	72	65	39	5	0	181	21.73%
South	74	23	95	17	1	210	25.21%
Southwest	46	27	10	0	0	83	9.96%
West	30	15	0	0	0	45	5.40%
Northwest	7	0	0	0	0	7	0.84%
	340	191	198	62	42	<= Counts	
	40.82%	22.93%	23.77%	7.44%	5.04%	<= Percent	

Regional Considerations

An overview of a data set pair is included here for the eastern half of Texas. A list of exceedance days is included below (tables A-13 and A-14), which covers the August 25 - September 4, 1998 and the September 13 - 20, 1999 periods.

Table A-13. Regional Considerations, 1998

	Highest Daily Maximum by Area, 8-hour ozone average												
Exceedance Days for San Antonio	**1998**	Dallas-Fort Worth	Tyler	Longview-Marshall	Beaumont-Port Arthur	Houston-Galveston-	Austin	San Antonio	Victoria	Corpus Christi	Laredo	McAllen-Edinburg-	Brownsville-Harlingen
	8/25	79	63	63	45	72	44	30	23	23	24	25	19
	8/26	83	68	85	82	111	42	31	17	26	20	23	14
	8/27	90	84	104	87	132	62	56	51	42	29	28	16
X	8/28	84	87	114	93	114	84	89	55	52	36	33	30
	8/29	84	83	96	87	**149**	88	84	72	75	52	38	31
X	8/30	100	85	73	99	118	92	92	48	42	56	33	27
	8/31	96	78	82	46	72	84	74	60	49	33	31	26
	9/1	102	73	73	41	53	79	69	47	53	54	44	41
	9/2	120	99	86	62	75	74	76	62	82	55	64	56
X	9/3	100	91	107	94	**152**	101	87	71	76	51	41	36
X	9/4	92	90	96	97	128	95	110	78	78	50	59	63

Table A-14. Regional Considerations, 1999

	Highest Daily Maximum by Area, 8-hour ozone average												
Exceedance Days for San Antonio	**1999**	Dallas-Fort Worth	Tyler	Longview-Marshall	Beaumont-Port Arthur	Houston-Galveston-Brazoria	Austin	San Antonio	Victoria	Corpus Christi	Laredo	McAllen-Edinburg-Mission	Brownsville-Harlingen
	9/13	49	43	45	66	82	55	64	67	70	48	47	50
	9/14	69	60	58	64	88	62	66	67	76	61	50	54
	9/15	80	85	75	70	97	78	82	78	82	56	70	68
X	9/16	78	82	79	89	104	85	85	79	81	65	68	66
	9/17	99	86	75	69	111	99	76	86	81	55	64	57
X	9/18	99	91	86	101	98	99	96	87	89	61	71	66
X	9/19	96	91	97	100	120	101	91	84	88	59	71	55
X	9/20	92	99	110	79	124	87	86	99	75	53	65	54

The near non-attainment areas for the 8-hour ozone NAAQS in Texas are Austin, San Antonio, Tyler-Longview-Marshall, Victoria and Corpus Christi for the 1997-1999 period. If a combined, regional photochemical model was to be undertaken by these areas, the September 1999 episode is preferable, in that there are no 8-hour exceedances for Corpus Christi or Victoria in the 1998 data set.

CONCLUSION

Historical data reveals two annual periods of likely high ozone exceedances: May-July and August-October, with the central occurences in late June - early July and late August - late September. The 1995 Base Case Photochemical Model now with AACOG extends from July 7 August 28, 30 and September 3, 1998 through July 12th. The two final episode candidates are represented by the September 16, 18-20, 1999 exceedance days or the August 28, 30 and September 3, 1998 exceedance days. The 1995 Base Case and either of the two final candidates represent the two seasonal periods.

The wind patterns for these two candidate episodes do follow the patterns of direction given in the wind roses fairly well. According to the wind roses for high ozone days, the morning winds are most likely to come from the south to southeast. According to CAMS 23 (Marshall High) data, the morning winds for the episodes in question come from (on average) the south or southeast. And the afternoon winds do swing to a more easterly direction. CAMS 23 has been in place since 1996, and so will most closely match the 1998-1997 data in the wind roses. Details of wind speed, resultant wind speed, and wind direction during the exceedance days, by monitoring station, are provided in tables A-15 through A-22. Wind direction, the direction from which the wind is blowing, is measured to the nearest degree based on a 360 degree compass with 360 degrees being from the North and 180 degrees being from the South.

Table A-15. Wind Speed and Resultant Wind Speed at CAMS 58, 1998 and 1999 Episodes

Camp Bullis, CAMS 58					
August - September 1998	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
28-Aug-98	82.25	4.10	3.63	5.78	4.68
30-Aug-98	87.50	5.13	4.65	5.53	4.80
03-Sep-98	87.38	3.88	3.30	3.68	2.75
04-Sep-98	110.25	3.13	2.35	4.43	3.20
Average		4.06	3.48	4.85	3.86
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
16-Sep-99	78.25	5.10	4.48	7.95	6.98
18-Sep-99	96.75	4.03	3.05	6.08	4.50
19-Sep-99	91.13	3.73	2.80	5.43	3.85
20-Sep-99	81.88	4.23	3.50	5.73	3.83
Average		4.27	3.46	6.29	4.79

Table A-16. Wind Direction at CAMS 58, 1998 and 1999 Episodes

Camp Bullis, CAMS 58			
August - September 1998	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	1-3:59 p.m. Average Resultant Wind Direction
28-Aug-98	82.25	327	109
30-Aug-98	87.50	122	120
03-Sep-98	87.38	279	201
04-Sep-98	110.25	253	160
Average		245	147
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	1-3:59 p.m. Average Resultant Wind Direction
16-Sep-99	78.25	194	110
18-Sep-99	96.75	236	148
19-Sep-99	91.13	246	175
20-Sep-99	81.88	258	172
Average		233	151

Table A-17. Wind Speed and Resultant Wind Speed at CAMS 678, 1999 Episode*

CPS/Trinity Pecan Valley C678					
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
16-Sep-99	74.00	3.93	3.35	5.58	4.80
18-Sep-99	76.25	2.70	1.70	3.88	2.55
19-Sep-99	84.88	2.55	1.88	3.85	1.93
20-Sep-99	86.88	4.38	3.85	3.53	1.98
Average		3.39	2.69	4.21	2.81

Table A-18. Wind Direction at CAMS 678, 1999 Episode*

CPS/Trinity Pecan Valley C678			
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	8-10:59 p.m. Average Resultant Wind Direction
16-Sep-99	74.00	129	90
18-Sep-99	76.25	205	102
19-Sep-99	84.88	241	147
20-Sep-99	86.88	248	157
Average		206	124

*There is no data available at CPS/Trinity Pecan Valley C678 for August - September, 1998.

Table A-19. Wind Speed and Resultant Wind Speed at CAMS 23, 1998 and 1999 Episodes

Marshall High C23					
August - September 1998	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m.. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
28-Aug-98	89.13	2.98	2.33	6.13	5.55
30-Aug-98	90.88	5.28	4.93	5.45	4.98
03-Sep-98	76.00	5.28	3.78	4.88	2.40
04-Sep-98	93.50	3.13	2.70	4.35	2.98
Average		4.16	3.43	5.20	3.98
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m.. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
16-Sep-99	85.63	5.85	5.25	7.23	6.45
18-Sep-99	92.88	3.73	2.55	4.83	3.23
19-Sep-99	89.88	3.58	2.70	4.33	2.60
20-Sep-99	84.63	5.08	4.43	4.60	2.80
Average		4.56	3.73	5.24	3.77

Table A-20. Wind Direction at CAMS 23, 1998 and 1999 Episodes

Marshall High C23			
August - September 1998	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	1-3:59 p.m. Average Resultant Wind Direction
28-Aug-98	89.13	282	101
30-Aug-98	90.88	55	108
03-Sep-98	76.00	248	215
04-Sep-98	93.50	183	141
Average		192	141
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	1-3:59 p.m. Average Resultant Wind Direction
16-Sep-99	85.63	66	83
18-Sep-99	92.88	184	133
19-Sep-99	89.88	219	169
20-Sep-99	84.63	232	122
Average		175	126

Table A-21. Wind Speed and Resultant Wind Speed at CAMS 59, 1998 and 1999 Episodes

Calaveras Lake C59					
August - September 1998	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
28-Aug-98	66.25	4.58	4.23	5.73	4.95
30-Aug-98	74.38	8.00	7.78	5.70	5.03
03-Sep-98	78.00	6.03	5.75	4.03	3.35
04-Sep-98	78.75	3.70	3.38	4.35	2.88
Average		5.58	5.28	4.95	4.05
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Wind Speed Average (mph)	8-10:59 a.m. Resultant Wind Speed Average (mph)	1-3:59 p.m. Wind Speed Average (mph)	1-3:59 p.m. Resultant Wind Speed Average (mph)
16-Sep-99	90.75	6.68	6.38	9.33	8.63
18-Sep-99	89.13	4.75	4.15	5.05	2.53
19-Sep-99	98.88	3.53	2.40	5.40	3.78
20-Sep-99	88.88	5.08	4.63	4.00	3.05
Average		5.01	4.39	5.94	4.49

Table A-22. Wind Direction at CAMS 59, 1998 and 1999 Episodes

Calaveras Lake C59			
August - September 1998	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	1-3:59 p.m. Average Resultant Wind Direction
28-Aug-98	66.25	232	83
30-Aug-98	74.38	46	127
03-Sep-98	78.00	256	99
04-Sep-98	78.75	197	99
Average		183	102
September 1999	8-hour O3 high (ppb)	8-10:59 a.m. Average Resultant Wind Direction	1-3:59 p.m. Average Resultant Wind Direction
16-Sep-99	90.75	35	59
18-Sep-99	89.13	31	175
19-Sep-99	98.88	169	106
20-Sep-99	88.88	259	80
Average		123	105

While the complete list of exceedance days showed five possible episode candidates, several factors cut the list down to two. These factors are: lack of meteorological data; less than three ozone exceedance days within a single identifiable period; episode sequence was not found during the 1997 through 1999 ozone season period.

For the remaining two candidates, September 16-20, 1999, or August 28 - September 3, 1998, an analysis of the back trajectories provided by the HYSPLIT model was performed. Comparing the back trajectories of historical ozone exceedance days with those of the exceedance days from each episode set, the September 16-20, 1999 trajectory set more closely resembled the desired balance of back trajectories. Moreover, the September 16-20, 1999 set showed a higher percentage of back trajectories from the east, a valuable asset, given the large number of NOx emitters found within 250 miles of San Antonio. However, a combination of the September 16-20, 1999 and the August 28 - September 3, 1998 episodes well filled the back trajectory requirements.

Finally, if regional modeling considerations are weighed, the September 16-20, 1999 is the most practical next modeling episode for most of the other near non-attainment areas to attempt. Of the two candidates, exceedance days for more of the five near non-attainment areas occured during the September 16-20, 1999 period. For these reasons, the September 16-20, 1999 is advised as the next photochemical modeling episode to be undertaken for photochemical modeling in the San Antonio region.